Abstract Book

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Rubber Compounding and Composites

Functionalized SBRs in Silica-reinforced Tire Tread Compounds: Interactions with Filler and Zinc Oxide

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Abstract: Unlike carbon black, silica is polar and naturally not compatible with non-polar hydrocarbon elastomers. This lack of interaction or compatibility between the filler and the elastomer typically causes lower properties compared to carbon black filled compounds. A common approach to deal with this problem is to utilize silane coupling agents in the system to link the silica and the polymer chains via covalent bonds. An alternative is the introduction of polar functional groups or chemically reactive groups into the elastomer chains which can give improved compatibility of elastomers with fillers such as silica.

In this work, the effect of three functionalized SBRs, one backbone modified with carboxylate moieties, one modified with dithiol groups and one partially Si-coupled, on the dynamic and mechanical properties of a silica-reinforced tire tread compound will be discussed and compared to a reference compound which contains unmodified s-SBR as the main polymer. The results show the significant potential of two of these modified SBRs to reduce rolling resistance of tire treads made thereof, while no major change in wet grip occurs.

Zinc oxide is known as the best activator for sulfur vulcanization. Zn-ions combine with accelerators to form an active complex which catalyzes the vulcanization process. However, in silica filled compounds, ZnO may interfere with the silanization process due to its alkaline nature, and it may compete with the silanes in reacting with the acidic -OH groups on the surface of silica particles. When functionalized SBRs with higher polarity are used in silica compounds, ZnO may interact with these moieties as well. In order to investigate the effect of ZnO on the properties of the silica-reinforced tread compound, a series of compounds have been prepared, in which ZnO addition in a later stage was compared to conventional mixing. Adding zinc oxide in a later stage of mixing shows very promising results favoring rolling resistance of tires made thereof, but brings along lower hardness values, which can affect other properties of the compounds, such as tire traction which leads to misinterpretations. Therefore, compounds of the ZnO-study with adjusted hardness are prepared through oil adjustment and/or change in the vulcanization system. Dynamic and mechanical properties of these compounds are studied and compared with the original data without hardness adjustment.